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Abundance and Run Timing of Adult Salmon in Tanada Creek in the Wrangell-St. Elias National Park and Preserve, 2004

Annual Report No. FIS04-502-1

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ANNUAL REPORT SUMMARY PAGE

Title: Abundance and Run Timing of Adult Salmon in Tanada Creek in the Wrangell-St. Elias National Park and Preserve

Study Number: FIS04-502-1

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Management Regions: Cook Inlet/Gulf of Alaska

Information Type: Fish stock status and trends

Issues Addressed: Tanada Creek salmon are highly susceptible to Federal and State subsistence users as well as commercial harvest. The Batzulnetas Area subsistence fisheries specifically target Tanada Creek salmon stocks. Monitoring Tanada Creek salmon stocks aids in assessing sockeye salmon escapement into the uppermost tributaries of the Copper River and in evaluating the harvest opportunity for subsistence fishers in the Batzulnetas Area fishery and the uppermost portion of the Glennallen Subdistrict. The dynamic nature of the flows in Tanada Creek has prevented a rigid picket weir from functioning successfully. The feasibility of a floating resistance board weir and a video counting tower as monitoring tools are tested in Tanada Creek.

Study Cost: $188,000

Study Duration: May 2004 to September 2006

Key Words: Batzulnetas, Copper River, Sockeye, Tanada Creek, Tanada Lake Stock/status and Trends, Use

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INTRODUCTION

The upper Copper River drainage provides spawning habitat for sockeye salmon, *Oncorhynchus nerka,* and Chinook salmon *Oncorhynchus tshawytscha*. Significant numbers of adult salmon are harvested in commercial drift gillnet operations near the mouth of the Copper River from mid-May to September. Salmon escapement into the upper Copper River system contributes to Federal and State subsistence fishing through September 30. The monitoring and evaluation of these runs is essential to ensure that Wrangell - St. Elias National Park and Preserve (WRST) maintains natural and healthy populations of fish as required by the Alaska National Interest Lands Conservation Act (ANILCA).

The Copper River system supports over 124 known stocks of sockeye salmon of which at least 12 occur above the confluence of the Copper and Slana Rivers (Roberson 1987). Two of these stocks migrate through Tanada Creek and spawn along the shores of Tanada Lake or in the lake outlet (Figure 1). Chinook salmon are present in incidental numbers in Tanada Creek (Veach and Scotton, 2001).

Tanada Creek sockeye are one of the uppermost runs of sockeye in the Copper River and support a subsistence salmon fishery both in the Copper River and in Tanada Creek. The native villages of Mentasta and Chistochina harvest salmon in the Batzulnetas fishery. Batzulnetas, the Ahtna name for the traditional fishing site on Tanada Creek, has been used by the Ahtna people for over 1,000 years (Kari, 1986). The Batzulnetas fishery was in litigation from 1985 –2000 as Katie John and others attempted to reestablish their traditional subsistence fishery. The "Katie John Decision" resulted in the expansion of Federal management of fisheries in waters under Federal jurisdiction throughout Alaska.

The Tanada Lake sockeye salmon stocks typically compose the largest population of sockeye spawning and rearing within Wrangell-St.Elias National Park/Preserve, among those stocks which spawn upstream of the Gulkana River. Good escapement data will allow us to assess the management of these important sockeye salmon stocks.

OBJECTIVES

Specific objectives for this study were:

1. to monitor annual variations in abundance and timing of sockeye and chinook salmon in Tanada Creek;
2. to compare video estimates with weir counts to determine the effectiveness of a video tower to estimate salmon escapement in Tanada Creek;

3. to test the feasibility of sampling water quality and zooplankton to determine if variations in water quality and zooplankton biomass correlate with variations in adult sockeye salmon escapement to Tanada Lake; and
4. to provide an educational opportunity for local students and residents to learn about the Tanada Creek salmon runs and how the weir counts help to provide information needed to manage subsistence fisheries on the Copper River.

METHODS

Study Area

Watershed Description

Tanada Creek is a third order perennial stream and a tributary to the upper Copper River in southeast interior Alaska (Figure 1). The stream flows through the Copper River Plateau and encompasses a watershed area of approximately 550 km^2. Originating at Tanada Lake (62°27'N, 143°23'W), Tanada Creek runs 30 km northwest to its confluence with the Copper River (62°37'N, 143°48'W). The terrain is nearly level to gently rolling throughout the creek basin and the stream gradient is less than 2%. The vegetation is dominated by mosses, sedges, dwarf birch and willows. Black and white spruce are the primary evergreens, with stands of cottonwoods interspersed. The soils are poorly drained and are underlain by shallow permafrost (USDA 1979). Annual precipitation in the area averages 39 cm and ambient temperature ranges from a high of 32° C to a low of - 46° C. Average annual temperature is - 2.5° C (NOAA 1995). Breakup normally occurs in May, and water bodies freeze in September or October.

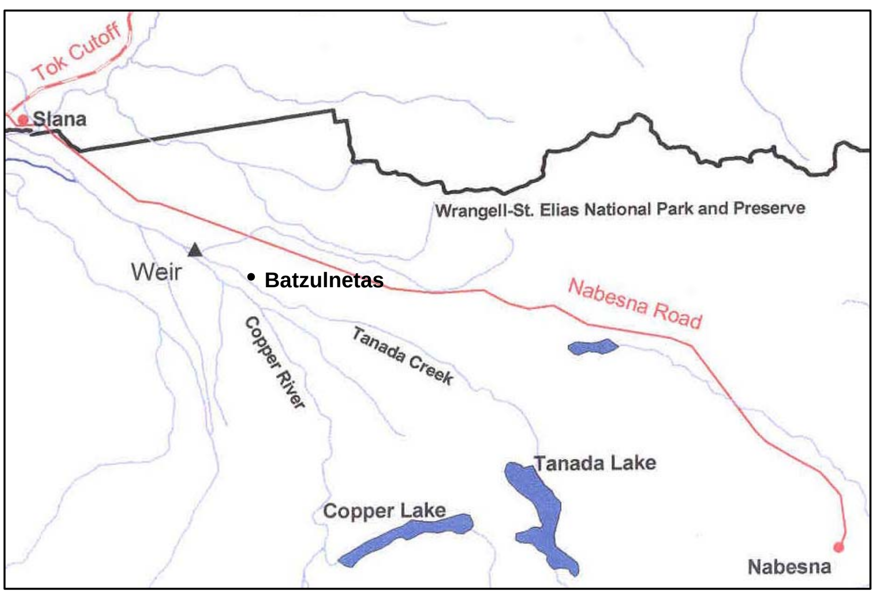


Figure 1. Tanada Creek and vicinity.

Weir Site Description

The weir site is located 920 m upstream from the Copper River and approximately 160 m downstream from the Batzulnetas village site (Figure 1). Stream width is about 9 m. The vertical banks are approximately 0.7 to 1.0 m high and bank undercutting ranges between 0 to 1 m. Maximum water depth at midstream during bank-full conditions is estimated at 1.2 m. Channel substrate is predominately cobble, with interstitial sand and gravel. The stream banks are stabilized by spruce, willow, alder and an understory of moss and horsetail ferns. Spruce and cottonwoods contribute to stream shading.

A permanent cross section was established on June 9, 1998 approximately 10 m upstream of the weir. Four brass cap reference markers were set along the transect. A staff-gage was placed in the stream near the north bank intersecting the cross section.

Weir Installation and Operation

In 2004 a floating resistance board weir was installed as described by Tobin (1994) (Figure 2). The weir, with picket spacing of 3.75 cm, was placed at the end of a straight 120 m section of stream with moderate water velocity and laminar flow. When resistance boards were in the "up" position the downstream end of the weir lay flat on the water surface. When resistance boards were in the "down" position, the downstream end of the weir was raised approximately 75 cm above the surface of the water (Figure 3). A sampling box, 1 m x 3 m, was constructed of 2 x 4 lumber, aluminum channel and cyclone fencing. Gates that could be raised and lowered were installed at either end to allow for holding, sampling, and releasing fish. The box was placed on the north bank side of the weir. The weir was installed during the week of May 25, and was operational beginning May 29. The weir was removed September 7 and was operated every day between installation and removal (Table 1). A staff gauge and water temperature reading was taken at the beginning of each shift. Gates on the box were closed when the weir was not monitored. The number of salmon counted was recorded hourly.

One *HOBO® TEMP* data logger was placed in a submersible case at the base of the staff gauge to collect water temperature data throughout the summer. The data logger recorded temperatures every hour and 30 minutes. Two depth readings were recorded daily; an average was calculated when different depths were recorded in a 24-hour period.

Figure 2. Constructing floating resistance board weir in Tanada Creek 2004.

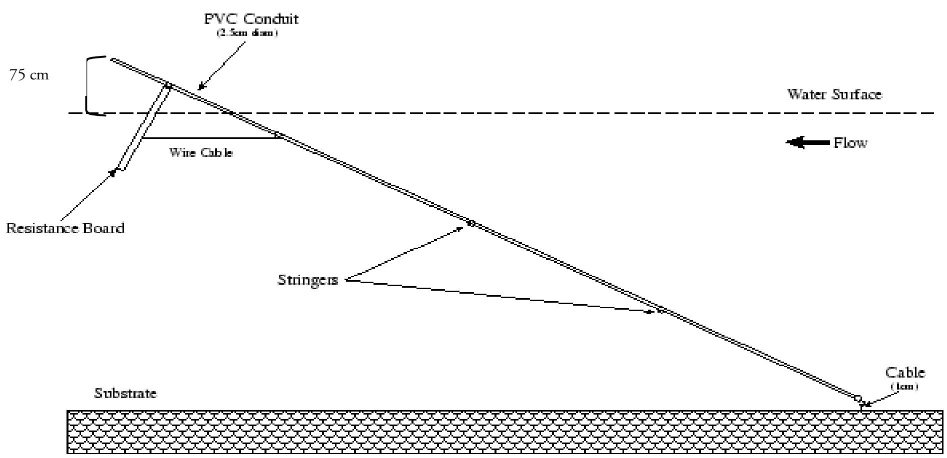


Figure 3. Placement of resistance boards in "down" position

Year	Start date	End date	Days operational
2000	June 8	July 13	2
2001	June 5	August 23	60
2002	June 27	August 15	49
2003	May 31	September 19	112
2004	May 29	September 7	101

Table 1. Dates of weir operation.

Biological Data

Sockeye salmon were sampled for scales and sexed using external characteristics. Two measurements were taken on each fish, from mid-eye to fork length (MEF) and mid-eye to posterior insertion of anal fin (anal) length. Lengths were recorded to the nearest millimeter. A tagging cradle was used to facilitate handling. Scales were collected from the preferred area, located on the left side of the fish and two rows above the lateral line on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin, according to Alaska Department of Fish and Game (ADFG) sampling protocol. One scale was taken from each sockeye salmon in accordance with this protocol. One scale is typically sampled from sockeye salmon while multiple scales would typically be sampled from chinook salmon (Steve Moffitt, personal communication). Sampled fish were marked with a round left opercle punch. Scale samples were analyzed by the ADFG Commercial Fisheries Division in Cordova. Ages were adjusted for resorbed margins based on length frequency aggregations.

Water flow was low in 2004 and water did not flow over the top of the panels. The integrity of the weir was inspected periodically by using a snorkel, mask and dry suit to check for gaps along the base of the weir. Daily monitoring of the weir took place and no fish leakage was observed around, under or over the weir in 2004 by the technicians working at the weir site.

Video Escapement Operation

In 2004, the video escapement recorder was installed on June 10, 10 m upstream from the weir. A 1.5 inch in diameter pipe 15 m long was affixed horizontally between two spruce trees on either side of the creek. A 3 mm cable was attached to the trees above the pipe and was looped through guides along the pipe to provide extra support. Two remote cameras, sealed in waterproof housings were suspended from the pipe above the water surface approximately 5.5 m (Figure 4). The cameras were equipped with a 3.5 mm ultra-wide angle lens to allow for field-of-view up to five meters. Four red lights were suspended with the cameras and aimed at the water surface. The lights were evenly spaced across the wetted width of the channel. Four more red lights were installed underwater, one on each bank pointing inward and one on each side of the center panel pointing towards each bank. A waterproof case containing a time-lapse frame recording system and multiplexer unit was housed on the north bank of the creek. Six 12-volt deep cycle batteries provided power to the system. An immersible water turbine served to provide power to the system and keep the batteries charged. A high contrast, permeable substrate panel was fixed to the streambed below the overhead cameras. This panel was approximately 1 m wide and was constructed of white PVC pipes that ran across the width of the creek and were spaced approximately 3 cm apart. Sandbags were placed along the downstream edge of the panel to keep fish from swimming under it. A vertical row of pickets 2 m high was placed in the streambed perpendicular to the panel. The pickets, which bisected the creek at approximately 4.8 m from each bank, served two purposes: (1) to delineate the midstream field of view of the two cameras, providing a defined edge for the mid stream frame of the video; (2) to prevent salmon from moving between one camera view and the other while swimming upstream. To eliminate glare from the water surface, an opaque plastic tarp was placed over the creek above the cameras.

The time-lapse recorder was programmed to capture one image every .15 seconds allowing for up to 64 hours of video to be collected on a single T-160 tape when recorded in extended play (EP) mode. The recorder was later reprogrammed to record in standard play (SP) mode, allowing for 48 hours of viewing on each T-160 tape. Tapes were changed every 48 hours. Regular VHS tapes were changed to S-VHS tapes after the crew had trouble viewing the recordings. The weir was operational in conjunction with the video cameras for 87 days.

Figure 4. Video counting tower in Tanada Creek.

Limnological Data

Limnological data was collected in Tanada Lake four times throughout the summer of 2004. The intervals between sampling dates were at least two weeks apart: sampling dates were June 21, July 18, August 12, and September 6. A fifth sampling event was unable to take place because of unfavorable weather conditions. Sampling took place from the floats of a plane. The two deepest areas of the lake were sampled both at the surface and at depth of (Figure 5). On-site water column parameters were measured for temperature, pH, specific conductance, and dissolved oxygen (DO). These were measured at 1 m intervals from the surface to the bottom using a Hydrolab meter. A Secchi disk was used to measure the depth of light penetration. Two water samples were collected at each site (at the surface and at depth approximately .5 m above bottom) and sent to Analytica, formerly Northern Testing Laboratory, to be measured for total nitrites/nitrates, total Kjeldahl nitrogen, total phosphate, and chlorophyll A. Analytica uses a quantitative detection method; their Method Reporting Limits (MRLs) are the lowest minimum concentrations at which a method or instrument will measure a relatively low value with low uncertainty in accuracy. The MRL for Kjeldahl nitrogen was 1.0 mg/L; for total phosphate, 0.025 mg/L; and for total nitrites/nitrates, 0.10 mg/L. Zooplankton tows were also taken at each site and sent to the EcoAnalysts, in Moscow, Idaho for identification to species and for calculation of the volumetric and areal density, body size and biomass. Alaska Department of Fish and Game Limnology Laboratory, where we formerly sent zooplankton specimens, has closed. The samples were taken with a 0.3 m diameter, 153 µm mesh conical net. The vertical tows were pulled from 50 m (or approximately .5 m above the bottom if shallower than 50 m) at a constant speed of 0.5 m sec $^{-1}$. All the specimens were preserved in neutralized 10% formalin (Koenings et al. 1987).

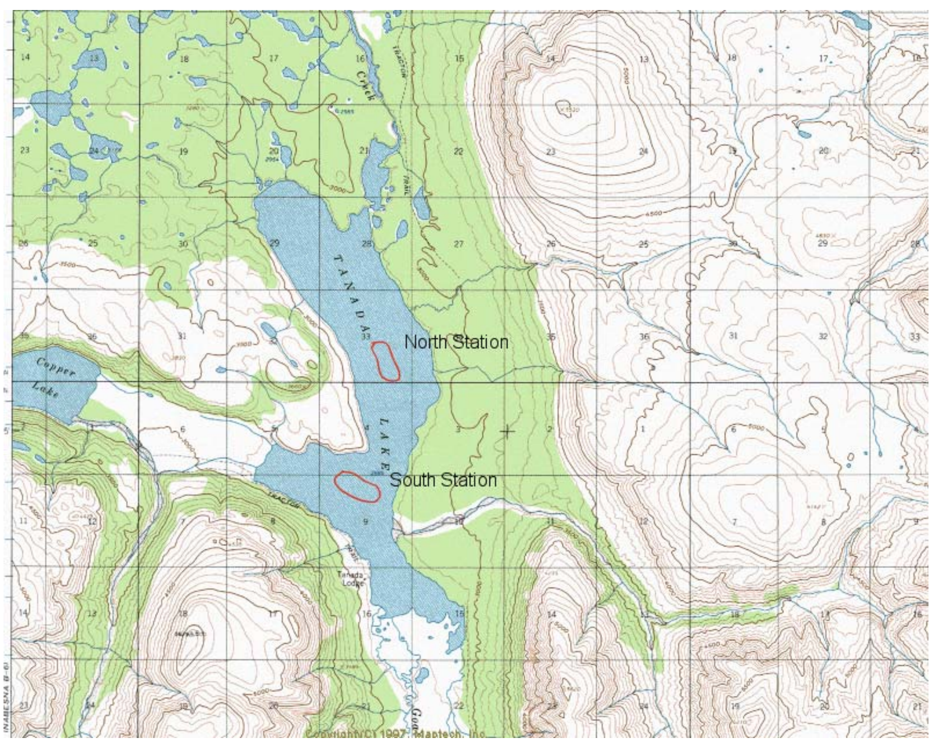


Figure 5. Location of North and South sampling stations, Tanada Lake

RESULTS

Weir Operation

The weir was operated during the dates displayed in Table 1. The floating resistance board weir was successfully operated in 2004. In 2004, staff gauge readings ranged from .30 feet to 1.65 feet, with a mean depth of 0.67 feet (Figure 6). Flows at these staff heights range from approximately 0.89 to 139.52 cubic feet per second (cfs) averaging around 17.48 cfs (based on a hydrostandard developed by the WRST park geologist, Danny Rosenkrans). In 2004, the flow was consistently low throughout the summer with a small spike around June 12 (Figure 6). Flows in 2004 were on average the lowest flows in the past three years (Figure 6). Temperature data for 2002 and 2004 is displayed in Figure 7 (the *HOBO® TEMP* data logger was lost in 2003). Throughout the majority of the summer, water temperatures were higher in 2004 than in 2002.

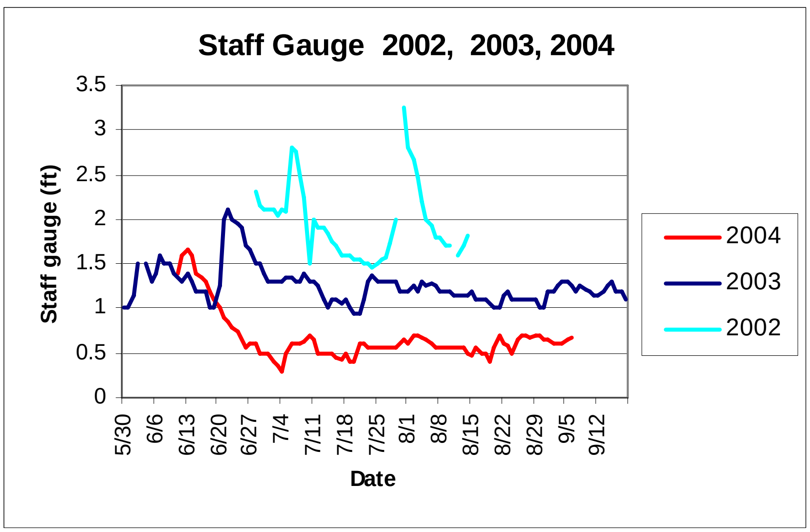


Figure 6. 2002, 2003 and 2004 staff gauge.

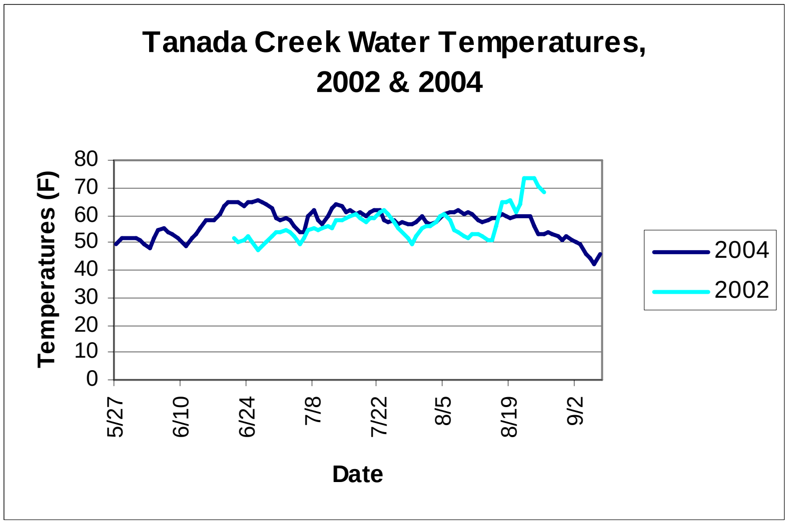


Figure 7. Water temperatures, 2002 & 2004.

Biological Data

Total sockeye salmon, *O. nerka*, observed at the weir are displayed in Table 2. In 2004, the number of sockeye salmon observed totaled 17,120 (Table 2.) No Chinook salmon, *Oncorhynchus tshawytscha*, were observed. A total of 920 sockeye were sampled for length and sex information in 2004. Scales were also taken from these 920 sampled fish of which 769 were readable. Length and sex information is displayed in Tables 3, 4, 5 and 6. The majority of the population (approximately 70 percent) sampled in 2004 was composed of 1.3 age class fish (Table 5), as was the majority of both males and females within each of the stratums sampled (Tables 3 and 4).

Year	Number of sockeye	Number of chinook
1997	20,729*	5
1998	28,992	2
1999	—	—
2000	—	—
2001	1,649	16
2002	6,186**	5
2003	5,856	2
2004	17,120	0

Table 2. Weir counts of sockeye salmon in Tanada Creek.

*Weir compromised by flood, estimate unreliably low.

** Estimate based upon mark-recapture sampling; the actual weir estimate was 2,489

Stratum Dates: May 29 - August 2, 2004											
Sex		Age Class								Total Fish Counted	N
		0.2	0.3	1.1	1.2	1.3	1.4	2.1	2.2		
F	Percent	0	0.9	0	26.8	71.8	0.5	0	0		213
	Number	0	46	0	1,299	3,486	23	0	0	4,853	
	SE		32		147	150	23				
M	Percent	0	1.4	0	25.6	73.1	0	0	0		219
	Number	0	68	0	1,276	3,645	0	0	0	4,989	
	SE		39		147	150					
Total	Percent	0	1.2	0	26.2	72.5	0.2	0	0		432
	Number	0	114	0	2,574	7,131	23	0	0	9,842	
	SE		51		208	212	23				

Table 3. Age and sex data, May 29 – August 2, 2004.

Stratum Dates: August 3 - September 7, 2004											
Sex		Age Class								Total Fish Counted	N
		0.2	0.3	1.1	1.2	1.3	1.4	2.1	2.2		
F	Percent	0.5	0.5	0	34.7	64.2	0	0	0		193
	Number	22	22	0	1,447	2,678	0	0	0	4,168	
	SE	22	22		242	144					
M	Percent	0	0.7	0	28.5	70.8	0	0	0		144
	Number	0	22	0	885	2,203	0	0	0	3,110	
	SE		22		117	118					
Total	Percent	0.3	0.6	0	32	67.1	0	0	0		337
	Number	22	43	0	2,332	4,881	0	0	0	7,278	
	SE	22	30		185	187					

Table 4. Age and sex data, August 3 – September 7, 2004.

Stratum Dates: May 29 - September 7, 2004											
		Age Class									
Sex		0.2	0.3	1.1	1.2	1.3	1.4	2.1	2.2	Total Fish Counted	N
F	Percent	0.2	0.7	0	30.5	68.2	0.2	0	0		406
	Number	22	67	0	2,746	6,164	23	0	0	9,021	
	SE	22	38		206	208	22				
M	Percent	0	1.1	0	26.7	72.2	0	0	0		363
	Number	0	90	0	2,161	5,848	0	0	0	8,099	
	SE		44		188	191					
Total	Percent	0.1	0.9	0	28.7	70.2	0.1	0	0		769
	Number	22	157	0	4,907	12,012	23	0	0	17,120	
	SE	22	59		279	282	23				

Table 5. Age and sex data, May 29 – September 7, 2004

May 29 - September 7										
Sex		Age Class								
		0.2	0.3	1.1	1.2	1.3	1.4	2.1	2.2	2.3
F	Mean Length (mm)		573		531	582	590			
	SE		7.5		1.8	1.1				
	Sample Size		4		124	277	1			
M	Mean Length (mm)		605		566	613				
	SE		2.9		1.6	1.2				
	Sample Size		4		97	262				
Total	Mean Length (mm)		589		546	597	590			
	SE		7.2		1.7	1.1				
	Sample Size		8		221	539	1			

Table 6. Age, sex, length data, May 29-September 7, 2004.

Run Timing

In most years, sockeye salmon are first observed at the weir between the last week of June and the middle of July (Table 7). In 2004, the first sockeye salmon was observed at the weir June 11. Only one fish was observed on this date. Four hundred forty salmon were counted during the next week. (Figure 8). The median point in the run occurred August 2 when the cumulative total of sockeye salmon reached 8,560 (Table 7). The last sockeye was counted through the weir on September 4. The weir was removed on September 7. Migratory run timing in 2004 appears to be later than the mean (1998, 2001, 2002, 2003) but earlier than in 2003 (Figure 9).

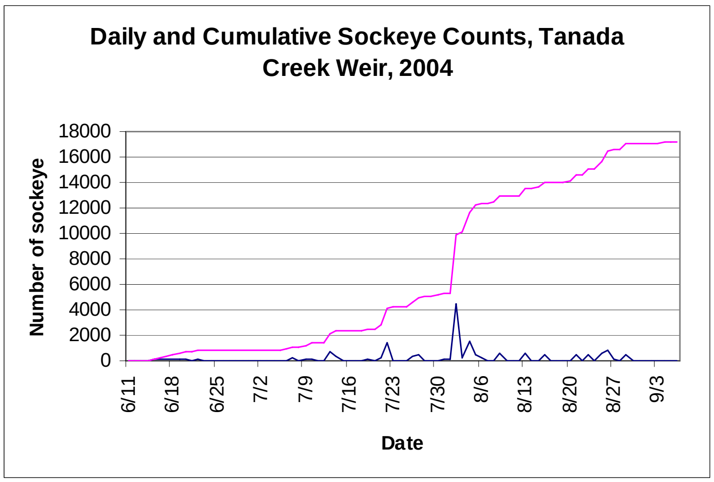


Figure 8. Cumulative and daily counts of sockeye salmon observations at the weir.

	First fish	Median date	Median Number
1998	13-Jul	19-Jul	14,496
2001	14-Jun	14-Jul	825
2002	28-Jun	12-Jul	3,094*
2003	11-Jun	5-Aug	2,929
2004	11-Jun	2-Aug	8,560

*extrapolated based upon total run size estimate

Table 7. Annual date of arrival of the first sockeye salmon and the median point of the sockeye migration past the weir.

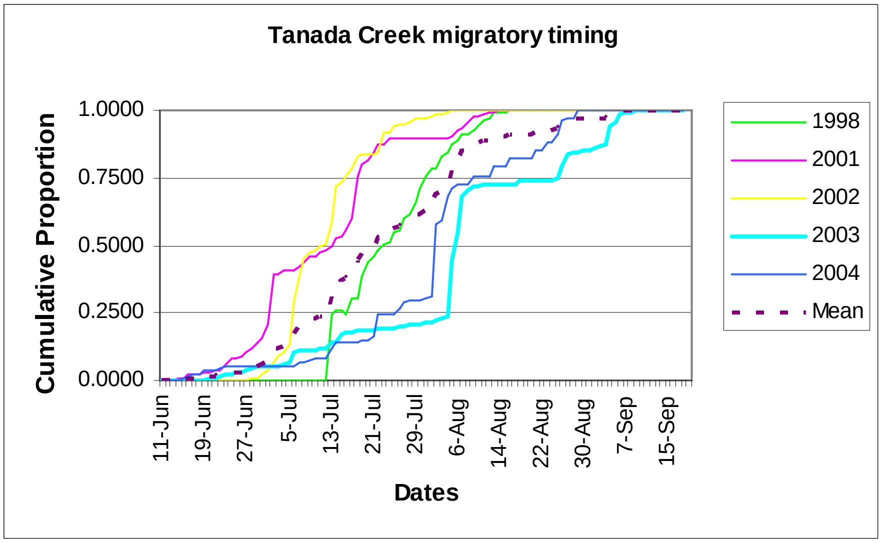


Figure 9. Migratory run timing, 1998-2004.

Capacity Building

The Batzulnetas culture camp took place from July 12 through July 15. During this week, when the crew was present, the weir was open to visitation.

In 2004, Wrangell-St.Elias National Park offered a Fisheries Biotech Training Program from July 7 – July 28 in the Slana area. The camp involved young people over the age of 18 and taught them a variety of skills and techniques including how to conduct scientific research, collect biological samples and data, determine fish abundance, and evaluate fish habitat. Training took place in the Slana/Nabesna area, with some of it at the Tanada Creek weir.

Video Escapement Estimation

In 2004, the video tower was erected and functioning while the weir was in operation. The upstream site selected for the video recording equipment provided full coverage of the creek. Forty-seven tapes recorded the creek from June 10 until the equipment was removed on September 8. Figure 10 shows the relationship between the number of fish counted through the weir on a daily basis and the number of fish counted on the tapes. There is a strong relationship between the video estimates and the weir counts. Approximately 89 percent of the sockeye salmon counted in the weir were also enumerated in the video estimates. A combination of the 2003 and 2004 weir daily count vs. the video count shows that approximately 88 percent of the counted fish were also observed on the video (Figure 11).

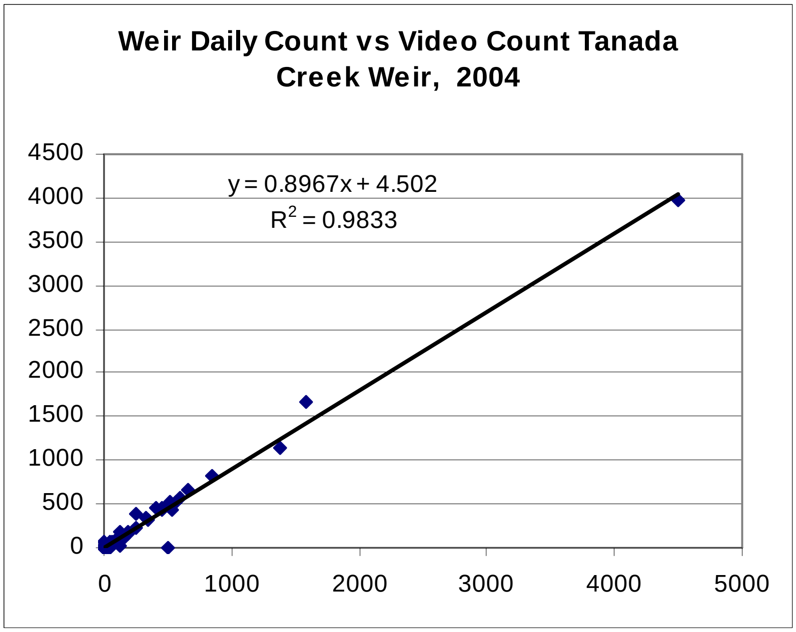


Figure 10. Relationship between daily weir fish counts and video estimates, 2004.

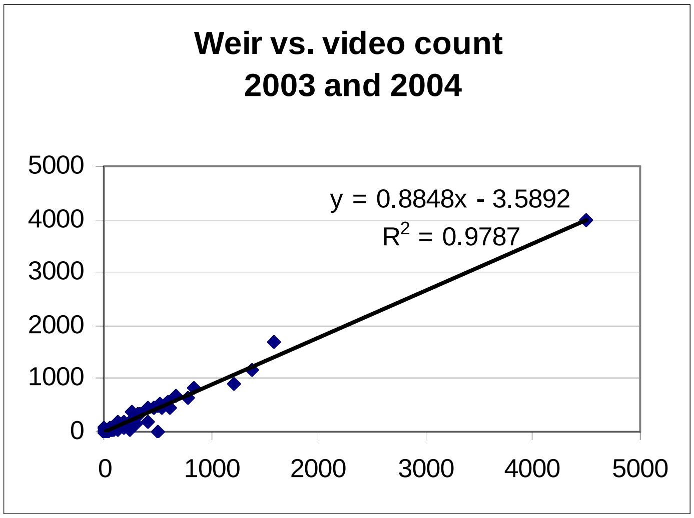
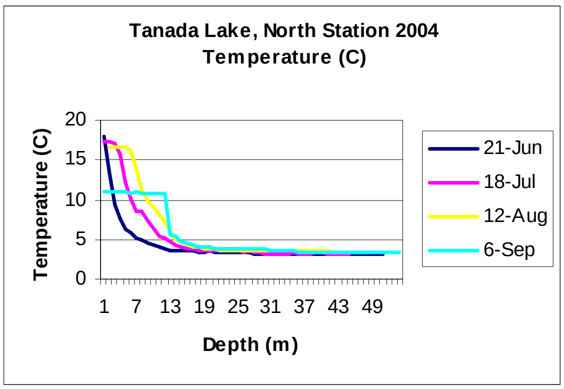


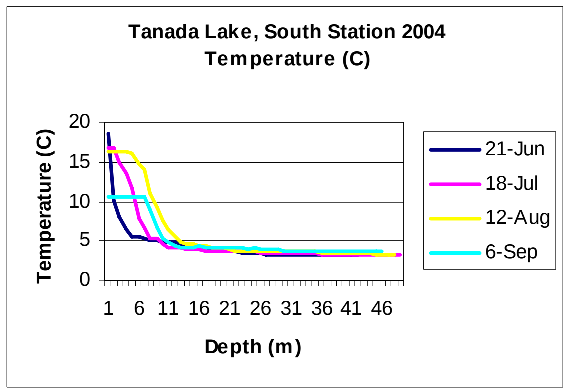
Figure 11. Relationship between daily weir fish counts and video estimates, 2003 and 2004 combined.

There were some problems with the cameras in 2004. Occasionally one of the cameras would freeze (for as much as 90 minutes at a time) while the other camera continued to record. It only affected one camera at a time and it was usually the same camera. Several attempts were made to alleviate this problem (e.g. we cleaned the heads, replaced the VCR) but none of them eliminated the problem. In the fall of 2004 the equipment was sent to be repaired and a part was replaced on the multiplexer.

Limnological Data

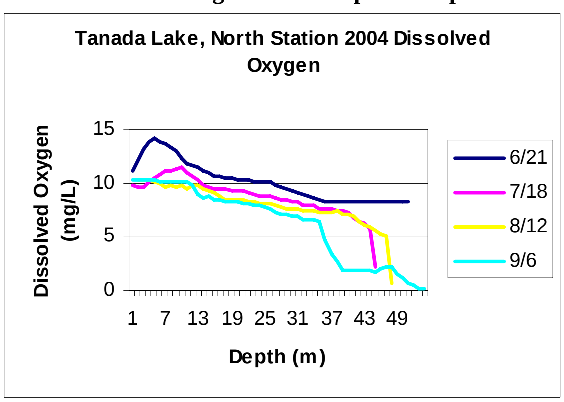
Limnological data at Tanada Lake was collected on 4 occasions in 2004. Surface temperature varied from 10.63° C on September 6 to 18.54° on June 21. Temperatures at depth (approximately 50 m) varied from 3.19° C on June 21 and July 18 to 3.62° C on September 6 (Figure 12). Dissolved oxygen at the surface was highest (11.55 mg/L) on September 6 and lowest (9.75 mg/L) on July 18. At depth, DO measurements varied from 8.2 mg/L (50 m) on June 21 to 0.11 mg/L (49 m) on July 18 (Figure 13). The pH surface measurements varied from 7.95 on 6/21 to 9.94 on September 6; at depth they ranged from 7.14 (50 m) on June 21 to 7.60 (53 m) on July 18 (Figure14). A water column profile of pH measurements was not taken on July 18. The measurements were taken only on the surface and at depth on that date. Specific conductance was not measured on July 18, but for the other 3 dates the surface range was from 0.104 mS/cm on June 21 to 0.120 mS/cm on September 6 and from 0.131 mS/cm at 50 m on June 21 to 0.216 mS/cm at 53 m on September 6 (Figure 15).

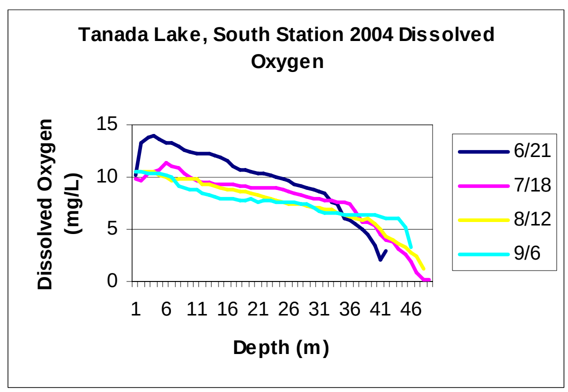




Temperatures at North Station **Temperatures at South StationFigure**

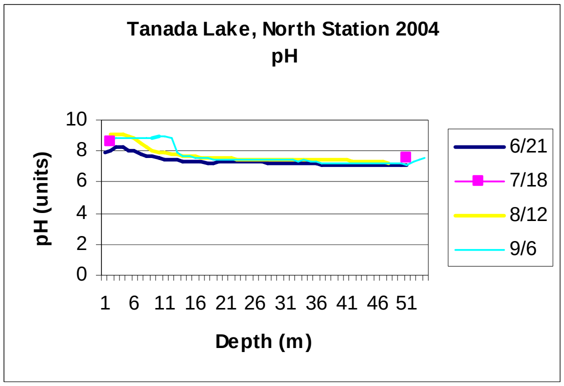
Figure 12. Temperature profiles at North and South stations Tanada Lake, 2004.



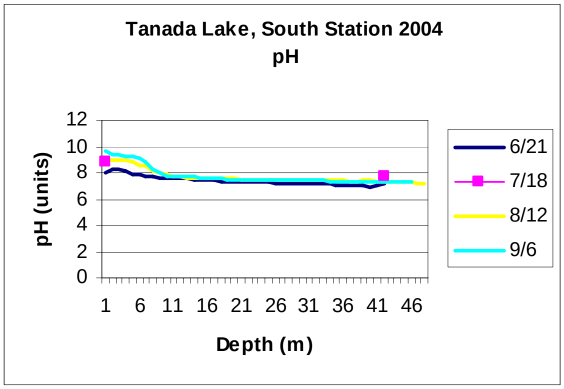


Dissolved oxygen North Station **Dissolved oxygen South Station**

Figure 13. Dissolved oxygen profiles at North and South stations Tanada Lake, 2004

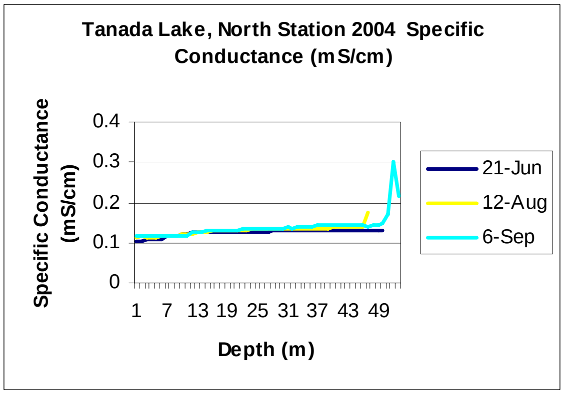


pH North Station

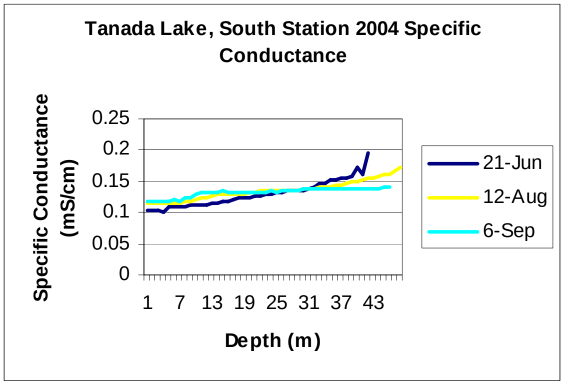


pH South Station

Figure 14. pH profiles at North and South Stations, Tanada Lake, 2004



Specific conductance North Station



Specific conductance South Station

Figure 15. Specific conductance profiles at North and South Stations, Tanada Lake, 2004

The average of the temperature profiles was higher at the North station in July and September and higher at the South station in June and August (Table 8). The average of the DO profile was higher at the North station in June, July and August and higher at the South station in September (Table 9). The average water column profiles of specific conductance show that it was higher at the North station in September and at the South station in June and August. Specific conductance measurements were not taken in July because of equipment problems (Table 10.) The average of the pH profile was higher at the South station in June, August, and September. A pH profile was not taken in July because of equipment problems, although surface and depth readings were measured (Table 11).

Date	6/21	7/18	8/12	9/6
North Station **Temperature** Profile Average °C	4.24	5.49	5.89	5.34
South Station **Temperature** Profile Average °C	4.5	4.9	6.12	5.26

Table 8. Average temperatures at North and South stations.

Date	6/21	7/18	8/12	9/6
North Station **DO Profile** Average (mg/L)	10.079	8.772	7.986	6.158
South Station **DO Profile** Average (mg/L)	9.714	7.632	7.524	7.749

Table 9. Average dissolved oxygen measurements at North and South stations

Date	6/21	8/12	9/6
North Station **Specific Conductance** Profile Average (mS/cm)	0.125	0.131	0.138
South Station **Specific Conductance** Average (mS/cm)	0.130	0.135	0.132

Table 10. Average specific conductance measurements at North and South stations.

Date	6/21	8/12	9/6
North Station **pH Profile** Average (units)	7.372	7.698	7.704
South Station **pH Profile** Average (units)	7.407	7.706	7.811

Table 11. Average pH measurements at North and South stations.

Tables 12 and 13 show the lab results for total Kjeldahl nitrogen (TKN), total phosphate (TP), total nitrites/nitrates, and chlorophyll A. Chlorophyll A samples were taken only on the surface. On September 6 two samples were taken for testing at the North Station. Some of the lab results for nutrients were low, coming in below the Method Reporting Levels for nitrogen, phosphate and nitrite/nitrate.

North Surface	TKN (mg/L)	TP(mg/L)	Total Nitrites/ Nitrates (mg/L)	Chlorophyll A (mg/m3)
6/21/2004	<MRL	0.0116	<MRL	
7/18/2004	<MRL	<MRL	<MRL	1.43
8/12/2004	<MRL	<MRL	<MRL	15
9/6/2004	<MRL	0.122	<MRL	7.15
9/6/2004	<MRL	0.16	<MRL	6.86

North Depth	TKN (mg/L)	TP(mg/L)	Total Nitrites/ Nitrates (mg/L)
6/21/2004	0.89	0.129	0.128
7/18/2004	1.06	0.036	0.152
8/12/2004	<MRL	<MRL	<MRL
9/6/2004	<MRL	0.167	<MRL
9/6/2004	<MRL	0.211	<MRL

Table 12. Measured lab analysis, North station.

South Surface	TKN (mg/L)	TP(mg/L)	Total Nitrites/ Nitrates (mg/L)	Chlorophyll A (mg/m3)
6/21/2004	<MRL	0.318	<MRL	
7/18/2004	<MRL	<MRL	<MRL	0.719
8/12/2004	1.39	0.101	<MRL	25.4
9/6/2004	<MRL	0.257	<MRL	2.76

South Depth	TKN (mg/L)	TP(mg/L)	Total Nitrites/ Nitrates (mg/L)
6/21/2004	0.89	0.0183	0.138
7/18/2004	5.03	0.204	0.115
8/12/2004	<MRL	<MRL	<MRL
9/6/2004	2.03	0.788	<MRL

Table 13. Measured lab analysis, South station

Zooplankton tows showed the presence of 5 taxa of macrozooplankton: *Diaptomus, Cyclops, Bosmina, Daphnia,* and *Copepod*. The June sample from the North station was too muddy to analyze. Two samples were taken at the North station on September 6 for comparison. These two samples, which were taken at the same location and within 20 minutes of each other differed substantially (tow A was done first) (Table 14). The zooplankton community was predominantly *Cyclops* (55% of the mean density at the North station and 66% of the South station), followed by *Daphnia* (combined *rosea* and *longiremis*) (22% at the North station and 18% at the South station) and then *Diaptomus* (15% and 9% respectively). There were also *Bosmina* and *Copepod nauplii.*

The seasonal mean density (No/m^2) of all taxa at the North station was 1,742,623. (Table 14) The North station mean biomass of all the taxa (dry weight mg/m^2) was 9,112.

The seasonal mean density (No/m^2) for the 5 taxa at the South station was 1,028,551. The South station mean biomass of all the taxa (dry weight, mg/m^2) was 3,395.

In August an algal bloom that covered 90 – 95 percent of the lake was observed. At the September sampling the bloom was still in evidence and covered approximately 60 percent of Tanada Lake.

North Station							
Macrozooplankton Density							
(no/m^2)							
	6/21	7/18	8/12	9/6a	9/6b	Seasonal Mean	Percentages
Diaptomus	m s	300,600	128,570	264,380	441,845	260,761	15
Cyclops	u a	1,256,715	762,360	492,545	1,267,580	966,379	55
Bosmina	d m	173,840	121,325	65,190	72,435	121,326	7
Daphnia l.	d p	7,245	59,755	304,220	170,220	101,407	6
Daphnia r.	y l	90,540	193,760	706,225	420,110	282,489	16
Copepod nauplii	e	21,730	3,620	3,620	7,245	10,261	1
Totals		1,850,670	1,269,390	1,836,180	2,379,435	1,742,623	100

*Average of 9/6a and 9/6b used for seasonal mean.

Macrozooplankton Density						
(no/m^2)						
	6/21	7/18	8/12	9/6	Seasonal Mean	Percentages
Diaptomus	99,595	101,405	81,490	101,405	95,974	9
Cyclops	1,043,035	789,520	610,250	282,490	681,324	66
Bosmina	12,675	72,435	23,540	39,840	37,123	4
Daphnia l.	1,810	7,245	21,730	115,895	36,670	4
Daphnia r.	10,865	14,485	106,840	450,895	145,771	14
Copepod nauplii	112,270	5,435	7,245	1,810	31,690	3
Totals	1,280,250	990,525	851,095	992,335	1,028,551	100

Table 14. Macrozooplankton density by species, North and South stations, 2004.

DISCUSSION

Weir Operation

The floating resistance board weir was installed correctly in 2004 and performed well. There were no flood waters during the 2004 field season and the weir was operable from May 29 to September 7. We were able to install the weir before the end of May, well before returning salmon have been documented in Tanada Creek in previous years. In 2004, the technicians checked the weir periodically both above the water surface and below using a mask and snorkel and no fish leakage was observed. No gaps greater than 3.75cm were observed between the weir and the substrate. Water flows were low throughout the season which assisted in maintaining the integrity of the weir (Figure 6). Therefore, no mark and recapture event was necessary in 2004.

However, there were problems created by the low flows in 2004. The sampling box was located on the shallow side of Tanada Creek and there was little flow through the box when the staff gauge was under 0.6 feet which happened on 40 days. A second, temporary sampling box was installed on the deeper side on July 26 and was used, when needed, to sample salmon during the summer.

Biological Data

The adult sockeye salmon population returning to Tanada Creek in 2004, estimated at 17,120, was approximately 19 percent higher than the mean of 13,817 for the 5 years that salmon have been successfully enumerated at the weir's present location (Figure 16). The majority (75%) of the returning adults were five year-old fish having spent two years in freshwater and three years in marine waters (Table 5). The second highest age class group for all three years was 1.2 age fish. No chinook were observed returning to Tanada Creek in 2004.

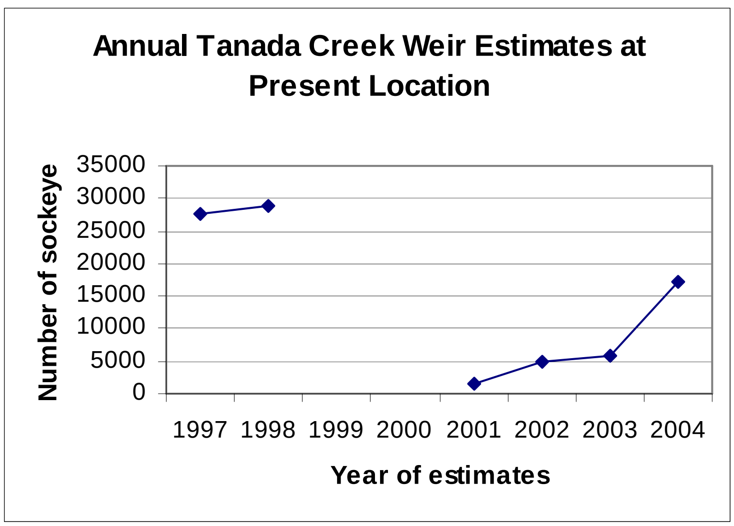


Figure 16. Estimated escapement by year.

Post-season analysis of commercial harvest and escapement at Miles Lake indicated a good return of sockeye salmon throughout the Copper River Basin (ADFG). Based on the 26-year average of 609,413 sockeye salmon, escapement in 2004 of 669,646 salmon was about 9 % higher than average (Table 15).

Year	Total Salmon	Year	Total Salmon	Year	Total Salmon	Year	Total Salmon
1978	107,011	1985	436,313	1992	601,952	1999	848,921
1979	237,173	1986	507,477	1993	833,387	2000	587,592
1980	276,538	1987	483,478	1994	715,577	2001	833,569
1981	535,263	1988	488,398	1995	599,215	2002	816,825
1982	467,306	1989	607,797	1996	906,867	2003	695,233
1983	545,724	1990	581,859	1997	1,148,079	2004	669,646
1984	536,806	1991	579,435	1998	866,957		

Table 15. Miles Lake Sonar Fish Counts

Sockeye escapement in Tanada Creek has fluctuated substantially during the years the weir has been in operation from a high of 28,992 in 1998 to a low of 1,660 in 2001 (Table 2). During those years the sockeye harvest in the Batzulnetas fishery has varied from a high of 582 in 1998 to a low of 62 in 2001 (the years that there was no harvest reported were years that no permits were issued) (Table 15). The reported harvest has been generally higher during years of high escapement and lower during years of low escapement. In 2004 the ratio of the number of fish harvested in the Batzulnetas fishery to the number of fish counted at the weir was the lowest on record (Figure 17) although there still appears to be a correlation (R^2 =0.83) between the weir escapement and the reported harvest (Figure 18.) In Figure 19 the trend line has been forced through zero: assuming that when no fish were counted through the weir, no fish were harvested at Batzulnetas. In 2004 there were several weeks during the fishing season when the only Batzulnetas fish wheel was inoperable because of damage caused by the high flows in the glacially fed Copper River.

Year	Permits Issued	Sockeye Harvest	Year	Permits Issued	Sockeye Harvest
1987	8	22	**1996**	0	0
1988	0	0	**1997**	1	428
1989	0	0	**1998**	3	582
1990	0	0	**1999**	1	55
1991	0	0	**2000**	0	0
1992	0	0	**2001**	1	62
1993	1	160	**2002**	1	208
1994	4	997	**2003**	1	164
1995	4	16	**2004**	1	182

Table 16. Participation and harvest in the Batzulnetas fishery, 1987-2004.

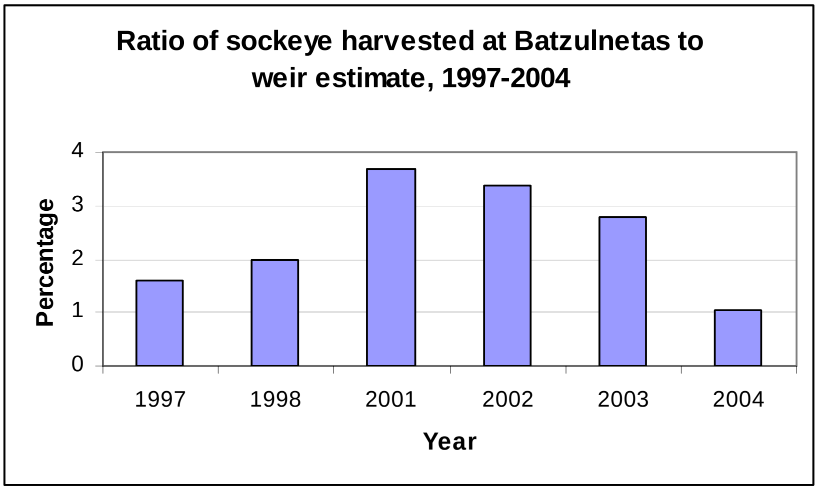


Figure 17. Ratio of Batzulnetas harvest vs. weir estimate.

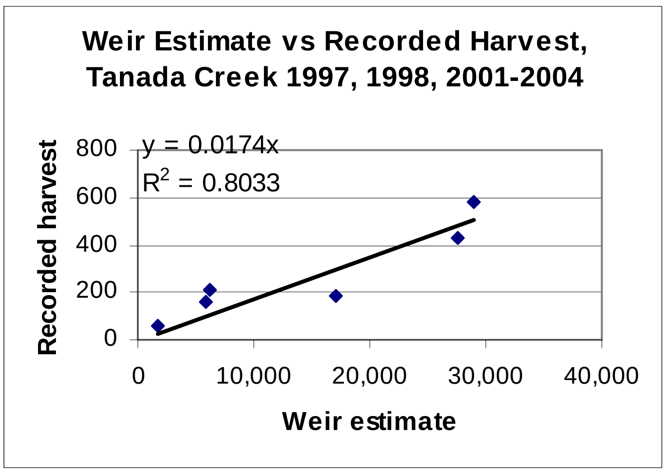


Figure 18. Weir estimate compared with reported harvest.

Run Timing

Table 7 demonstrates that the run timing of the Tanada Creek stocks appear to be highly variable. Determining a median run date that could be used to forecast the total run size in-season would be useful to managers. However, with the high variability in run timing during the 6 years the weir has operated since 1997, this does not yet appear to be possible. The average median run date, based on the data collected since 1997, occurs on July 17. But since other variables that might affect migratory run timing, such as water discharge or climatic warming trends, have not yet been identified or assessed, prediction of run size by simply using the average median run date is not effective.

Capacity Building

During the Batzulnetas culture camp, WRST provided a forum for community members to observe the weir project in operation and to ask questions about the abundance, timing and management of the Tanada Creek run. Four local residents of the Slana area were employed by WRST to staff the weir. Through this employment, they gained experience in monitoring, sampling, problem solving, and collecting, reporting and entering data. The Fisheries Biotech Training Program provided an arena for local young people to acquire marketable knowledge and skills.

Video Escapement Estimation

Video monitoring appears to be a potentially useful tool to estimate escapement in Tanada Creek. A wider contrasting panel was installed on the substrate under the cameras that created a larger viewing area and improved the video viewers' ability to count fish. An addition of another 2 feet of panel on the downstream edge of the viewing area would help next summer. In mid-summer a second Sony S-VHS time lapse recorder was purchased which allowed the crew to view the videos in a timelier manner than in the past. This alerted the crew to recording problems and allowed them to try to make improvements. When viewed, approximately 89 percent of the fish counted at the weir were observed as opposed to 70 percent in 2003. There was a strong correlation between the number of fish enumerated per day at the weir and the number counted on the tapes, $R^2 = 0.98$. (Figure 10) There was a noticeable difference in the level of accuracy among the four people viewing the video tapes ranging from almost 90 percent to -6 percent. Two people viewed the majority of the tapes (95 percent) and counted the majority of the fish (95 percent) and their accuracy levels were approximately 89 percent and 85 percent. The plastic tarp over the entire video monitoring installation reduced the reflective glare from the water. Even more glare could be reduced by installing a small tarp to reduce light on the west bank of the creek. The addition of an extra set of red lights and the placement of four lights underwater greatly improved night recording. The low flows throughout the season also resulted in good water clarity which likely improved the effectiveness of the video cameras. Further improvements in the substrate panels and glare reduction may result in an even higher R^2 value in the future. We feel it is important to continue the operation of the weir in conjunction with the video cameras and that the video cameras should be tested thoroughly at high flows before they are used to solely estimate escapement in Tanada Creek. However, existing work suggests that this may be a feasible substitute for operating the weir in the future.

Limnological Data

Water temperature on the surface was highest in August and lowest in June. The temperatures at depths below 13 m varied little between stations and sampling events. Dissolved oxygen levels were highest across the water column at the June sampling for the North station and highest in

June at the South station down to approximately 34 m. Over all, DO levels were lowest in September. The pH levels below approximately 13 m varied little; at the surface they were highest in September and lowest in June. Specific conductance showed a spike at depth during August and September at the North station and in June at the South station.

Many of the nutrients tested at NTL came back below Analytica's Method Reporting Limits: 1.0 mg/L for Kjeldahl N, 0.25 mg/L for total phosphate, 0.1 mg/L for total nitrites/nitrates. Forty six percent of the Kjeldahl N samples, forty six percent of the total P and seventy three percent of the total nitrates/nitrites fell into this category. Because of this it is difficult to compare the sampling events of 2004 or to compare the nutrient levels between 2003 and 2004. During the summer we searched for a testing laboratory that had lower measuring parameters for chemical analysis. In August we found a lab at the University of Missouri – Columbia and the September water sample was analyzed by them as well as by Analytica (the results are not included in the methods section of this report since it was only a single sampling). Table 17 shows the nutrient analysis from the University of Missouri – Columbia.

	Total Nitrogen (μ/L)	**Total Phosphorous (μ/L)**	**Total Nitrates (μ/L) ****
9/6/2004			
North Surface	180	14	0
North Surface (replicate)	170	15	0
North Depth	160	34	0
North Depth (replicate)	250	35	108
South Surface	190	14	0
South Depth	150	34	42

** Nitrate data is questionable because the water was frozen for several weeks and not filtered initially.

Table 17. Nutrient data for 9/6 sampling event in Tanada Lake (University of Missouri).

The zooplankton tows showed high productivity but varied between the North and South stations. Analysis shows that the samples from the North station had much higher density and biomass than those from the South station. Two zooplankton tows were taken in succession in September at the North station. The results from these show a high variability in the density of all 5 taxa between the 2 samples (Table 14). Comparing the 2003 and 2004 zooplankton in Tanada Lake shows higher densities and biomass in 2004 than in 2003 (Table 18). Total seasonal mean biomass (North and South stations averaged) in 2003 was 3,592 mg/m^2; in 2004 it was 6,254 mg/m^2.

Tanada Lake Zooplankton Density and Biomass, 2003 and 2004				
	North station		**South station**	
	2003	2004	2003	2004
Seasonal mean density (no./m^2)	1,640,829	1,742,623	957,173	1,028,551
Seasonal mean biomass (mg/m^2)	4,859	9,112	2,324	3,395

Table 18. Tanada Lake zooplankton density and biomass, 2003 and 2004.

According to John Edmundson (personal communication), Fishery Biologist from the ADFG Limnology Lab, several lakes in the Copper basin (Crosswinds, Copper, and Paxson) also show high zooplankton activity although it is generally low in cold, oligotrophic Alaskan lakes. Compared to similar data collected from four other oligotrophic salmon bearing Copper basin lakes, zooplankton biomass was high in 2003 and 2004.

	Summit Lake*	Crosswinds Lake**	Paxson Lake***	Copper Lake****
Mean biomass (mg/m^2)	503	1,101	1,349	2,092

*ADFG data from 1981-1998
**ADFG data for 11 years between 1982 and 1998
***ADFG data for 13 years between 1982 and 1998
****ADFG data from 1981

Table 19. Mean zooplankton biomass from four Copper basin lakes (personal communication Mark Willette).

CONCLUSIONS

Weir Operation

The floating resistance board weir outperformed the rigid picket weir and can be successfully operated at this site but some changes need to be made for more efficiency during low water years.

Biological Data

The escapement into Tanada Creek in 2004 was the highest since 1998. Age composition of the majority of salmon migrating through the weir was similar to that in 2001, 2002 and 2003.

Run Timing

The first fish was seen on June 11 which is the 2nd earliest date that fish have migrated through the weir and the median run date for the 2004 Tanada Creek escapement was on August 2 which is the second latest. Run timing appears to be highly variable in Tanada Creek. The average median run date does not appear to be a useful tool for projecting total run size using the existing data.

Video Escapement Estimation

Adding two new lights and installing four of the lights under water greatly improved night time recording. Enlarging the contrasting panels on the substrate increased the area that was available for counting fish when viewing. A tarp over the recording area decreased the amount of glare on the water. A correlation was drawn between the weir count of sockeye salmon and the video count with approximately 89 percent of the sockeye salmon that passed through the weir daily also observed by the video viewer. We believe that this may be a useful tool for estimating sockeye salmon escapement in Tanada Creek, however more work, particularly during periods of high flows, is needed to develop an index of weir counts and video escapement estimates. And the accuracy of the correlation between the daily count and the video count appears to be dependent on the viewer.

Limnological Data

This year's limnological data contributed to baseline nutrient level data from Tanada Lake. Measurements of nutrients occasionally were less than the method reporting limit used by Northern Test Labs, complicating the analysis of this data. Zooplankton measurements suggest that zooplankton production is high within the lake.

RECOMMENDATIONS

Weir Operations

1. Construct a sampling box in the deeper part of the creek to alleviate migration problems if there is low flow next summer.

Video Escapement Operation

1. Continue operating the video escapement operation in conjunction with the weir to produce a reliable index of video estimates at a range of flow conditions.
2. Build a larger contrasting panel under the video cameras to extend the viewing area.

Management

1. Continue monitoring to work towards defining what natural and healthy sockeye escapement is for Tanada Creek stocks.
2. Collect additional weir data to more accurately assess the trend in population abundance. While the aerial counts suggest a downward trend, additional weir data is likely to more accurately assess this trend.

Limnology

1. Continue the collection and analysis of water and zooplankton samples unless restricted by budgetary considerations.

ACKNOWLEDGEMENTS

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Appendix A. Tanada Creek daily salmon counts.

	Daily sockeye salmon count	cumulative sockeye	Daily kings	cumulative kings
5/29/04	0	0	0	0
5/30/04	0	0	0	0
5/31/04	0	0	0	0
6/1/04	0	0	0	0
6/2/04	0	0	0	0
6/3/04	0	0	0	0
6/4/04	0	0	0	0
6/5/04	0	0	0	0
6/6/04	0	0	0	0
6/7/04	0	0	0	0
6/8/04	0	0	0	0
6/9/04	0	0	0	0
6/10/04	0	0	0	0
6/11/04	1	1	0	0
6/12/04	3	4	0	0
6/13/04	18	22	0	0
6/14/04	36	58	0	0
6/15/04	66	124	0	0
6/16/04	69	193	0	0
6/17/04	125	318	0	0
6/18/04	122	440	0	0
6/19/04	144	584	0	0
6/20/04	73	657	0	0
6/21/04	2	659	0	0
6/22/04	155	814	0	0
6/23/04	23	837	0	0
6/24/04	2	839	0	0
6/25/04	3	842	0	0
6/26/04	0	842	0	0
6/27/04	0	842	0	0
6/28/04	1	843	0	0
6/29/04	0	843	0	0
6/30/04	0	843	0	0
7/1/04	0	843	0	0
7/2/04	0	843	0	0
7/3/04	7	850	0	0
7/4/04	1	851	0	0
7/5/04	1	852	0	0
7/6/04	48	900	0	0
7/7/04	191	1091	0	0
7/8/04	16	1107	0	0
7/9/04	118	1225	0	0
7/10/04	148	1373	0	0

7/11/04	7	1380	0	0
7/12/04	16	1396	0	0
7/13/04	665	2061	0	0
7/14/04	326	2387	0	0
7/15/04	1	2388	0	0
7/16/04	5	2393	0	0
7/17/04	9	2402	0	0
7/18/04	0	2402	0	0
7/19/04	110	2512	0	0
7/20/04	3	2515	0	0
7/21/04	252	2767	0	0
7/22/04	1375	4142	0	0
7/23/04	44	4186	0	0
7/24/04	36	4222	0	0
7/25/04	1	4223	0	0
7/26/04	340	4563	0	0
7/27/04	414	4977	0	0
7/28/04	51	5028	0	0
7/29/04	54	5082	0	0
7/30/04	47	5129	0	0
7/31/04	108	5237	0	0
8/1/04	104	5341	0	0
8/2/04	4501	9842	0	0
8/3/04	256	10098	0	0
8/4/04	1583	11681	0	0
8/5/04	522	12203	0	0
8/6/04	187	12390	0	0
8/7/04	0	12390	0	0
8/8/04	36	12426	0	0
8/9/04	538	12964	0	0
8/10/04	7	12971	0	0
8/11/04	5	12976	0	0
8/12/04	9	12985	0	0
8/13/04	572	13557	0	0
8/14/04	16	13573	0	0
8/15/04	16	13589	0	0
8/16/04	458	14047	0	0
8/17/04	0	14047	0	0
8/18/04	0	14047	0	0
8/19/04	0	14047	0	0
8/20/04	27	14074	0	0
8/21/04	460	14534	0	0
8/22/04	3	14537	0	0
8/23/04	500	15037	0	0
8/24/04	30	15067	0	0
8/25/04	592	15659	0	0
8/26/04	844	16503	0	0
8/27/04	81	16584	0	0

8/28/04	1	16585	0	0
8/29/04	498	17083	0	0
8/30/04	8	17091	0	0
8/31/04	22	17113	0	0
9/1/04	0	17113	0	0
9/2/04	0	17113	0	0
9/3/04	0	17113	0	0
9/4/04	7	17120	0	0
9/5/04	0	17120	0	0
9/6/04	0	17120	0	0